

# Angiosperm Reproduction: Flowers, Fruits, and Seeds

## Overview

In this lab you will observe assorted flowers, fruits, and seeds to better understand the unique adaptations of and the life cycle of angiosperms.

## Objectives

1. Identify the **bold** parts and their functions of a typical angiosperm flower, fruit, and seed.
2. Describe the life cycle of an angiosperm.
3. Identify an angiosperm as a dicot or a monocot on the basis of number of flower parts, number of cotyledons, and pattern of leaf venation.
4. Examine a flower or fruit and determine the carpel number.

## Part I

### Floral Anatomy

Although the flowers of angiosperms show a tremendous diversity (80% of all species of plants are angiosperms) the structures that make up the flower are basically the same for all species. The following parts are recognized although not all may occur in any one flower. The supporting stalk of the flower is called the pedicel.

A receptacle is at the center base of a flower and represents the end of the stem. In some cases it may form a dome for the other appendages or a cup with some appendages on the rim and others on the bottom. It is not usually a large or very noticeable part of most flowers.

The **calyx**, composed of **sepals**, makes up the lower or outermost whorl of floral appendages. Usually these are small and leaf-like, although different in shape from the other foliage leaves of the plant. Their major function is the protection of the immature inner parts, but in some cases they look and function as petals as well (lily).

The **corolla**, composed of **petals**, rises inside and usually above the sepals, usually being brightly pigmented and very broad. These serve as additional protection in early stages and later to attract pollinators. Some serve as "landing pads for the pollinator, and may have glands (nectaries) at the base which produce sweet nectar and/or volatile oils to provide the pollinator with a scent trail to the flower. The wind-pollinated angiosperms usually do not have petals or the petals are green.

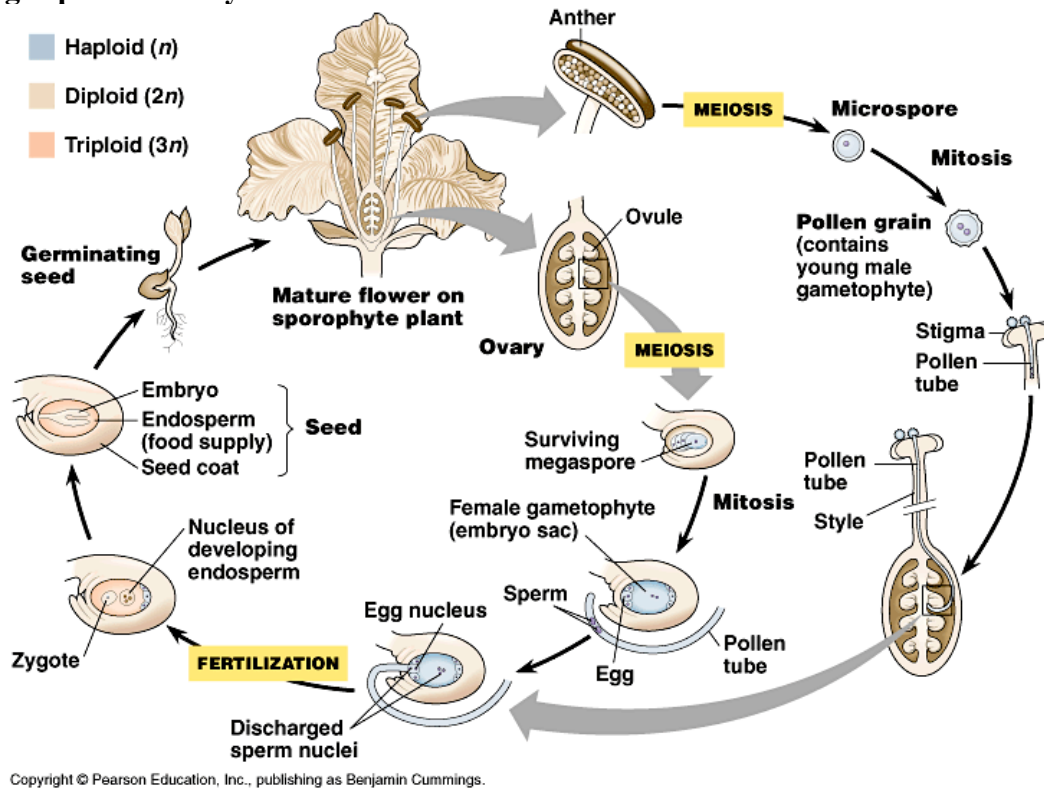
The male reproductive structures are the **stamens**, present inside the petals. Each stamen consist of a slender stalk or **filament** and variously shaped, enlarged sacs called **anthers**. Inside the anther, special groups of cells (**microsporangia**) undergo meiosis to produce **microspores**. The microspores divide by mitosis to become the **male gametophytes - pollen grains**. (see textbook figure 38.4)

One or more **carpel (pistils)** may occur in the center of the flower. A **carpel** is composed of: (1) a **stigma** which produces a sticky substance which catches pollen grains and induces their germination; (2) a **style** through which the pollen tubes grow toward the ovules; and, (3) an **ovary** - the basal region which contains one or more ovules (**megasporangia**). It is within the ovule that one of the four **megaspores** will produce a female gametophyte. In angiosperms the female gametophyte contains eight nuclei at maturity and is called an embryo sac. One of the cells of the female gametophyte is an egg. (See textbook figure 38.4)

### Double Fertilization of Angiosperms

Two sperm are present in a pollen grain. A zygote (2n) results when one sperm unites with an egg inside an ovule within an ovary. The second sperm unites with the two polar nuclei of the embryo sac to form a triploid (3n) structure called the **endosperm**. Fertilization of both an egg and polar nuclei is called **double fertilization** and is unique to angiosperms (Figure 38.9 in textbook). The endosperm will devour the remaining embryo sac (female gametophyte) and provide food for the young sporophyte (2n) embryo during dormancy as well as during the process of germination. Examine Figure 1 (Figure 30.17 in text) on the following page of a typical angiosperm life cycle. Also examine textbook figure 38.4 to better understand how male and female gametophytes are created within a flower.

**Figure 1: Angiosperm Life Cycle**



## Part I

### Pre Lab Procedure

1. Print the unlabeled version of Figure 38.2 OR Figure 30.13a and label diagram with the following terms: anther, filament, ovary, ovule, petal, carpel, sepal, stamen, receptacle, stigma, and style.
2. Identify, by using three different colors, the gametophyte generation structures ( $n$ ), the sporophyte generation ( $2n$ ), and the triploid ( $3n$ ) endosperm in the life cycle diagram Figure 1.

### Procedure

1. Dissect a fresh or preserved flower using dissecting utensils and a stereoscope. Determine the following information concerning the dissected plant flower: General name, identify the flower parts present, determine if the flower complete or incomplete, determine if the flower is perfect or imperfect, determine if flower is a monocot or a dicot.
2. Make a sketch of your flower with all parts labeled in your lab notebook
3. If possible, obtain some pollen from one or more of the flowers present in class. Create a wet mount of the pollen and examine the pollen at 400X. Compare your pollen to figure 38.5 of the textbook.
4. Make a sketch of the pollen at 400x in your lab notebook.

## Part II

### Fruit

The fruit is the ripened ovary and the other structures that surround it at maturity, as the colors and patterns of flowers are adaptations for pollination, the shapes, colors, and other characteristics of fruits affect seed dispersal. The wall of the ovary is modified to become the fruit wall, or pericarp. Pericarps come in various textures and colors, and fruits are classified according to these and other characteristics. The pericarp is often differentiated into several layers: an outer exocarp, a middle mesocarp, and an inner endocarp. Simple fruits consist of a single ripened ovary plus any adherent parts such as sepals, stamens, or petals. Simple fruits may have many seeds. Most angiosperms have simple fruits, which are further categorized as follows.

**Fleshy fruits** have a pericarp that is soft and fleshy at maturity. Most of the structures we usually think of a "fruits" fall into this category. The most common types of fleshy fruits are:

- Berry** - Exocarp is skin-like, mesocarp is fleshy, and the endocarp is slimy or juicy. *Example: grape*
- Hesperidium** - A fruit with a leathery rind. *Example: orange*
- Pepe** - A fruit with a relatively hard rind. *Example: watermelon*
- Drupe** - Endocarp is papery, forming a core (pit) with several weeks; outer fruit composed of thickened receptacle tissue. *Example: peach*
- Pome** - Endocarp is papery, forming a core with several seeds; outer fruit composed of thickened receptacle tissue. *Example: apple*

**Dry fruits** have a pericarp that becomes dry and hard at maturity.

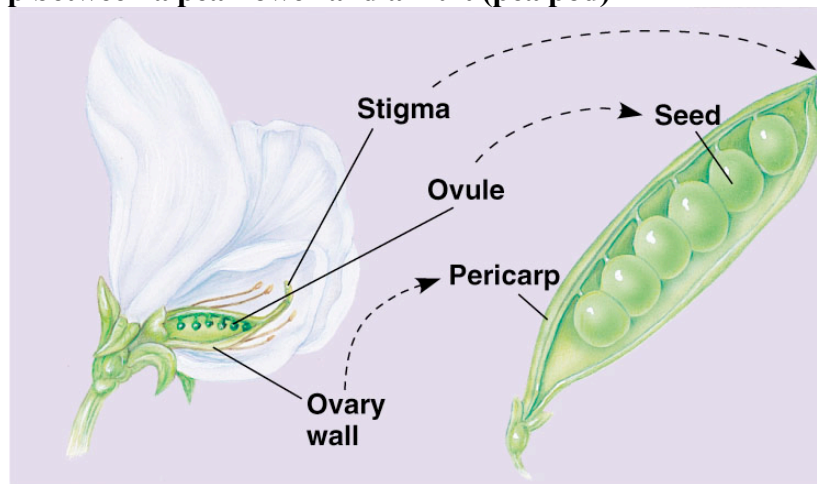
- Legume (pod)** - splits open along two seems. *Example: pea*
- Capsule** - Consists of two or more fused carpels and fruit splits open at maturity. *Example: lily*
- Idelhiscent dry fruits** do not split open at maturity. *Examples: grain, nuts*
  - **Grain** (caryopsis) - does not split open at maturity, contains single seed, seed coat fused to pericarp. *Example: corn*
  - **Nut** - a one-seeded fruit with a very hard pericarp. *Example: walnut*

**Aggregate fruits** consist of clusters of several or many ripened ovaries produces by a single flower and borne on same receptacle. *Example: raspberry*

**Multiple or compound fruit** consist of clusters of several or many ripened ovaries produces by several flowers in the same inflorescence. *Example: pineapple*

Figure 2 (text figure 30.15) displays the relationship between parts of a flower and the parts of a fruit. As you observe the fruit specimens in class, ask yourself, "From what part of the flower did this structure originate?"

**Figure 2: Relationship between a pea flower and a fruit (pea pod)**



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## Part II

### Pre Lab Procedure

1. Bring a fruit specimen to class. Be sure you know the name of the fruit and what part(s) of the fruit can be consumed by humans
2. Construct a data table in your lab notebook to organize observations of the myriad fruit specimens present in class. Include the following information: the name of fruit, nature of fruit (ex. Fleshy-pepe), number of seeds present, whether seeds are edible, what part(s) of fruit is (are) edible, evidence of flower parts (Yes or no: A scar-like structure appears on the ends of certain fruits showing remains of reproductive parts no longer necessary such as stigma, petals, or stamens. Do not confuse these old flower parts with the stalk end where the fruit was connected to the plant.)

## Procedure

1. Observe fruit specimens present in class. Complete the data table for all specimens present.
2. Potentially sample a variety of swollen ovaries!

## Part III

### Seeds

A seed contains a newly created sporophyte embryo and food reserves. Therefore, seeds are created by sexual reproduction. As you observed during the fruit lab portion of this lab, the number of seeds per fruit vary significantly from species to species. However, all seeds can be classified, as can plants from which they came, by determining the number of cotyledons present: 1 (monocot) or 2 (dicot).

In monocots, the food reserves are called the endosperm and are formed when one of the sperm present in pollen fertilized the two polar nuclei creating a triploid tissue. When moisture, temperature and oxygen levels are favorable, the sporophyte embryo will emerge from the seed in a process called germination (Figure 5). Since the sporophyte embryo is below ground and cannot do photosynthesis, hydrolysis of lipids and carbohydrates from the endosperm will fuel the growth of the embryo. Corn is an example of common monocot pictured in figure 3 below.

In dicots, such as beans, the food reserves are called cotyledons. As you probably determined, dicots have two cotyledons. During the process of germination of a dicot (Figure 5), the entire seed emerges from the ground, including the cotyledons. The cotyledons turn green and are, in fact, the first leaves of the plant. Eventually the food supply of the cotyledons is exhausted, and the cotyledons shrink in size until they no longer exist.

The embryos of both monocots and dicots possess the three major organs of a plant: roots, stems, and leaves. The embryonic stem is called a hypocotyl. The radicle is the embryonic root. The epicotyl is present above (or covering) the hypocotyl and will eventually become the leaves of the sporophyte. See figure 38.10 in your textbook for more information.

**Figure 3: Monocot Seed Structure**

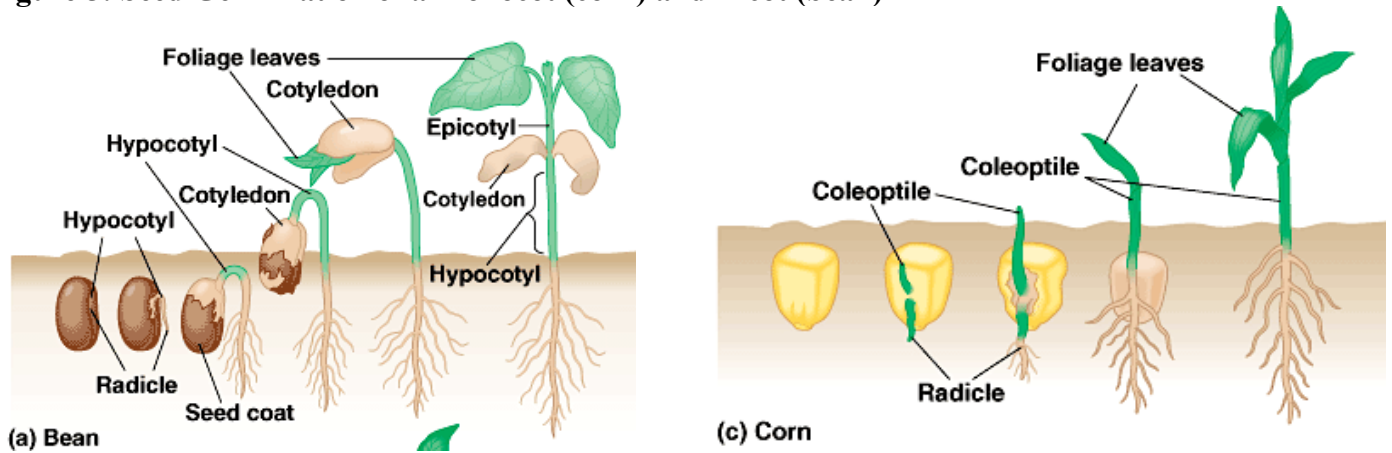


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**Figure 4: Dicot Seed Structure**



**Figure 5: Seed Germination of a Monocot (corn) and Dicot (bean)**



### Part III

#### Pre Lab Procedure

1. Use your textbook to label the following structures of a typical monocot seed in Figure 3 (text figure 38.11): **Endosperm, cotyledon (scutellum), coleoptile (sheath covering root meristem), radicle, and plumule**. Make a sketch of a labeled monocot seed in your lab notebook.
2. Identify the function of each of the structures listed in #1 in your lab notebook as well.
3. Use your textbook to label the following structures of typical dicot seed in Figure 4 (text figure 38.11): **seed coat, epicotyl, hypocotyl, cotyledon, radicle, plumule**. Make a sketch of a labeled dicot seed in your lab notebook
4. Identify the function of each of the structures listed in #3 in your lab notebook as well.

#### Procedure

1. Examine a bean seed that has been soaking in water for a few days.
2. Identify the **micropyle**, the minute opening on the surface through which the pollen tube grew and the **hilum**, the adjacent oval area where the ovule was attached to the ovary.
3. Next, carefully peel off the **seed coat**.
4. Separate the two large fleshy **cotyledons** which serve as an area for food storage in the bean.
5. Now identify the **epicotyl** (leaves), **hypocotyls** (stem) and the **radicle** that will produce the roots of the bean embryo.
6. Examine a peanut. The shell of the peanut is the fruit. Gently crack open the fruit without destroying the peanut seeds inside.
7. Each peanut seed has a brown, papery covering. This is the seed coat and is formed from ovule tissue. Gently remove the seed coat for one seed.
8. Examine one peanut seed. Do you see, at one end, a small structure poking out of the seed? That's the embryo. In order to view the embryo, carefully separated the two halves (cotyledons) of the seed.
9. Using a hand lens or stereoscope, examine the embryo that should be resting on one of the two halves of the cotyledon. Identify the epicotyl, hypocotyls, and radicle of the embryo.
10. Examine a corn seed that has been soaking in water for a few days.
11. Use a razor to split it longitudinally.
12. Add a drop of iodine to the cut surface. What does the iodine react with and turn black? Why? What is present in the endosperm of this seed?
13. Attempt to identify the features of your corn seed listed in prelab procedure step #1.